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Two new endemic *Pinnularia* species (Bacillariophyceae) from Japan

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日本固有のピヌラリア属二新種

辻 彰洋・渡辺 仁治

Abstract

Two new *Pinnularia* taxa, *Pinnularia acidobionta* sp. nov. and *Pinnularia kirisimaensis* sp. nov., are described. Both taxa are thought to be endemic to Lake Usori, Osorezan, Aomori, Japan and Fudo Pond, Kirishima, Kyusyu, Japan.

Key index words : Bacillariophyceae, endemic, Fudo Pond, Kirishima, Lake Usori, Osorezan, *Pinnularia acidobionta* sp. nov., *Pinnularia kirisimaensis* sp. nov.

Introduction

The diatom floras from acidic freshwaters have been reported by many Japanese diatomists (Negoro 1944, Hirano 1975, Watanabe & Yasuda 1982, Fukushima *et al*. 2002). Several new taxa described in these studies (Negoro 1944, Fukushima *et al*. 2001, Fukushima *et al*. 2002) are thought to be endemic to Japan. In the present study we also describe two new diatom taxa from two Japanese acidic freshwaters, from the Osorezan and the Kirishima areas.

Diatom flora from the Osorezan area including River Sho-zu, Lake Usori and several ponds at Gokuraku-hama, have been examined and several new diatom taxa have been described (Negoro 1944, Fukushima *et al*. 2001, Fukushima *et al*. 2002). The diatom flora from the Kirishima area including Fudo pond, have been reported by Watanabe & Oyanagi (1978). However, the information on the diatom flora from the Kirishima area is less than that from the Osorezan area.

Materials and methods

Twenty-six samples from the Osorezan area, Aomori, Japan (Table 1) and twenty-three samples from the Kirishima area, Kyusyu, Japan (Table 2) housed in TNS (Department of Botany, National Science Museum), were examined in this study. These specimens were observed using light microscopy (Axiophot : Zeiss, Germany) and photographed using a CCD (Charge Coupled Device) camera (DXM-1200 : Nikon, Japan) and printed after image processing. About 400 individuals were examined from both areas.

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Results

Pinnularia acidobionta **Tuji & Tosh.Watan., sp. nov.** **Figs 1-12**

Valvae lineares vel rhombico-lanceolatae, apicibus late rotundatis, 75-110 μm longae, 11-24 μm latae. Area axialis linearis vel ad nodulum centralem versus dilatata, circiter 1/2 latitudinis valvae extendens, area centralis lata, rhomboidea, asymmetrica, 1/3-1/2 latitudinis valvae. Striae transapicales radiantes in media parte valvae, convergentes ad apices, 9-10 in 10 μm, lineae speciosae longitudinales nullae.

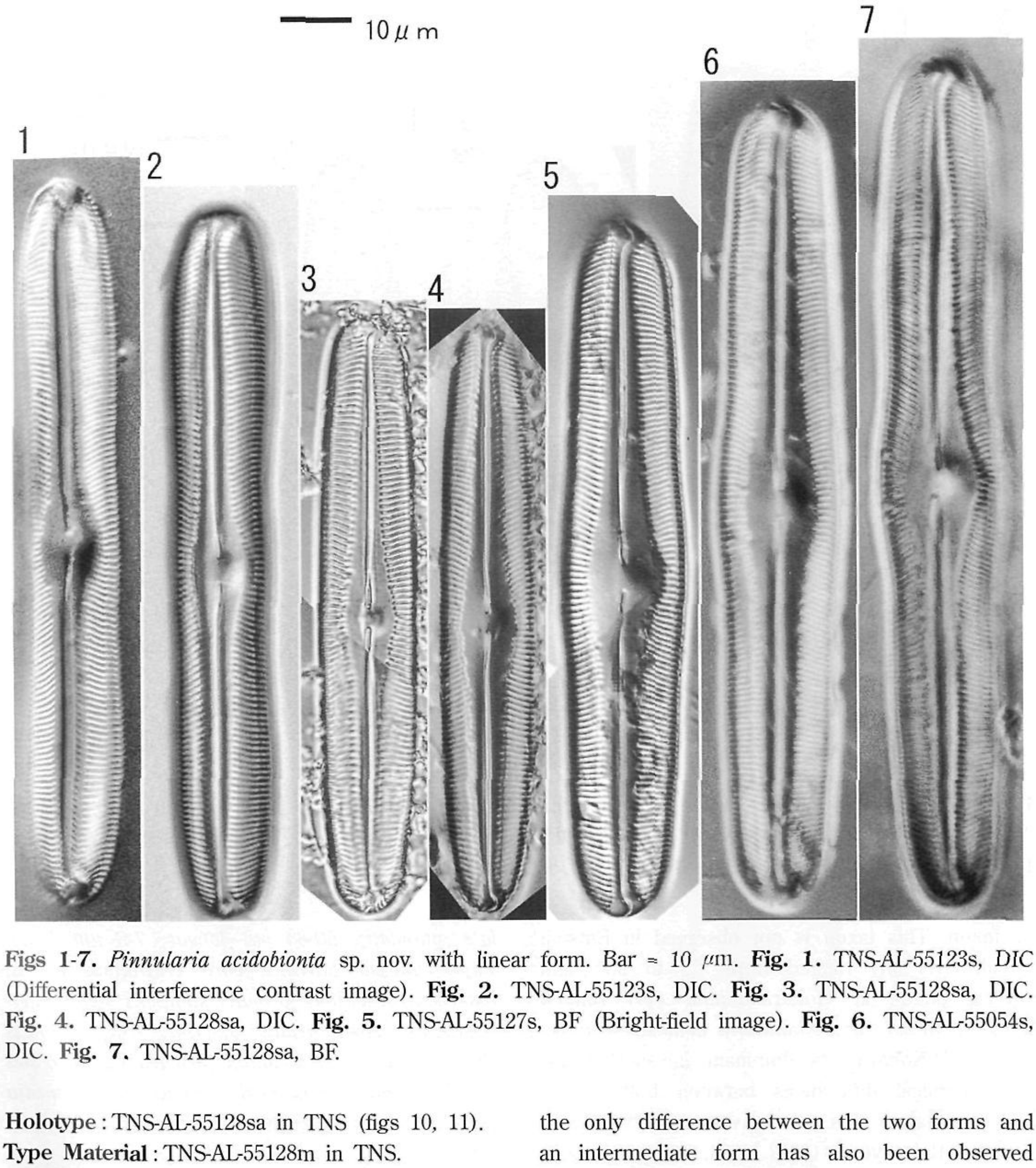
Valves linear to rhombic-lanceolate, ends broadly rounded, length 75-110 μm, breadth 11-24 μm. Axial area linear or tapering to the ends, 1/2 the breadth of the valve, central area large roundish-rhombic, 1/3-1/2 the breadth of the valve, commonly asymmetrical. Striae about 9-10/10 μm, radiate in the middle, convergent towards the ends. Longitudinal bands absent.

Table 1. Slide data used in this study from the Osorezan area, Japan. Measurements of pH and water temperature : (Temp.) at each sampling site and abundance of valve form (linear = linear form, rhomb. = rhombic – lanceolate form) of *Pinnularia acidobionta* on each slide (+ : rare, ++ : abundant, +++ : very abundant).

Slide Number (TNS-AL-)	Sampling information			measurements		abundance	
	Site	Date	Collector	pH	Temp.	linear	rhomb.
TW-5014sa	Entsu-ji	1972/8/24	T. Watanabe	2.7	–	–	–
TW-5015sa	River Sho-zu	1972/8/24	T. Watanabe	2.7	24.2	++	++
TW-5024sa	Lake Usori	1972/8/24	T. Watanabe	3.2	23.0	–	+
TW-5025sa	Lake Usori	1972/8/24	T. Watanabe	3.2	25.5	–	+
TW-5027sa	Lake Usori	1972/8/24	T. Watanabe	3.7	24.3	+	+
TW-5028sa	Lake Usori	1974/8/27	T. Watanabe	3.7	–	–	–
TW-5029sa	Lake Usori	1974/8/27	T. Watanabe	3.7	–	–	–
TW-6832sa	Lake Usori	1974/8/27	T. Watanabe	3.7	–	–	+
TW-6833sa	Lake Usori	1974/8/27	T. Watanabe	3.7	–	–	+
TW-6834sa	Lake Usori	1974/8/27	T. Watanabe	3.7	–	–	–
TW-6835sa	Lake Usori	1974/8/27	T. Watanabe	3.7	–	–	+
55053sa	River Sho-zu	1999/9/8	A. Tuji	–	–	+	–
55054sa	River Sho-zu	1999/9/8	A. Tuji	–	–	–	+
55055sa	Lake Usori	1999/9/8	A. Tuji	–	–	–	–
55083sa	River Sho-zu	2000/5/23	A. Tuji	3.5	–	–	+
55099sa	River Sho-zu	2003/4/20	A. Tuji	4.4	6.1	–	–
55100sa	River Sho-zu (branch)	2003/4/20	A. Tuji	6.7	6.6	–	–
55101sa	River Sho-zu	2003/4/20	A. Tuji	4.3	6.5	–	–
55121sa	Entsu-ji	2003/7/28	A. Tuji	1.3	50.3	–	–
55122sa	Lake Usori	2003/7/28	A. Tuji	2.5	19.8	–	+
55123sa	Lake Usori	2003/7/28	A. Tuji	2.0	33.2	–	+
55124sa	a pond, Gokurakuhama	2003/7/28	A. Tuji	1.3	23.5	–	–
55125sa	a pond, Gokurakuhama	2003/7/28	A. Tuji	–	–	–	–
55126sa	a pond, Gokurakuhama	2003/7/28	A. Tuji	1.7	20.4	–	–
55127sa	River Sho-zu	2003/7/28	A. Tuji	2.7	18.7	+	++
55128sa	Lake Usori	2003/7/28	A. Tuji	2.6	20.2	+	+++

Table 2. Slide data used in this study from the Kirishima area, Japan. Measurements of pH and water temperature : (Temp.) at each sampling site and abundance of *Pinnularia kirisimaensis* on each slide (+ : rare, ++ : abundant, +++ : very abundant).

Slide Number (TNS-AL-)	Sampling information			measurements		abundance
	Site	Date	Collector	pH	Temp.	
TW-6881sa	Fudo Pond, sediment (moss area)	1977/4/20	T. Watanabe	3.8	–	+++
TW-6882sa	Fudo Pond, sediment (moss area)	1977/4/20	T. Watanabe	3.8	–	+++
TW-6883sa	Fudo Pond, sediment (moss area)	1977/4/20	T. Watanabe	3.8	–	+++
TW-6884sa	Fudo Pond, sediment (moss area)	1977/4/20	T. Watanabe	3.8	–	+++
TW-6885sa	Fudo Pond, sediment (moss area)	1977/4/20	T. Watanabe	3.8	–	+++
TW-6886sa	Fudo Pond, sediment (moss area)	1977/4/20	T. Watanabe	3.8	–	+++
TW-6887sa	Fudo Pond, sediment (moss area)	1977/4/20	T. Watanabe	3.8	–	+++
TW-6888sa	Fudo Pond, sediment (open area)	1977/4/20	T. Watanabe	3.8	–	+++
TW-6889sa	Fudo Pond, sediment (open area)	1977/4/20	T. Watanabe	3.8	–	+++
TW-6890sa	Fudo Pond, attached to stake	1977/4/20	T. Watanabe	3.8	–	++
TW-6891sa	Fudo Pond, attached to wood	1977/4/20	T. Watanabe	3.8	–	++
TW-6892sa	Fudo Pond, attached to stone	1977/4/20	T. Watanabe	3.8	–	++
TW-6893sa	Fudo Pond, attached to silt	1977/4/20	T. Watanabe	3.8	–	+++
TW-6894sa	Fudo Pond, attached to bog moss	1977/4/20	T. Watanabe	3.8	–	++
TW-6897sa	Fudo Pond, attached to stone	1975/10/4	T. Watanabe	4.0	–	++
TW-6898sa	Fudo Pond, attached to silt	1975/10/4	T. Watanabe	4.0	–	+
TW-6899sa	Fudo Pond, attached to bog moss	1975/11/20	T. Watanabe	4.0	11.2	+
TW-10145sa	Fudo Pond	1985/2/16	T. Watanabe	6.5	2.2	+
55402sa	Fudo Pond, attached to stone	2003/12/3	A. Tuji	4.0	9.1	++
55404sa	Fudo Pond, attached to stone	2003/12/3	A. Tuji	3.4	12.2	++
TW-6915sa	Rokukannonmi Pond	1977/3/14	T. Watanabe	4.0	–	–
TW-6920sa	Byakushi Pond	1977/3/14	T. Watanabe	4.9	–	–
TW-6920sa	Ohnami Pond	1975/10/4	T. Watanabe	4.4	–	–



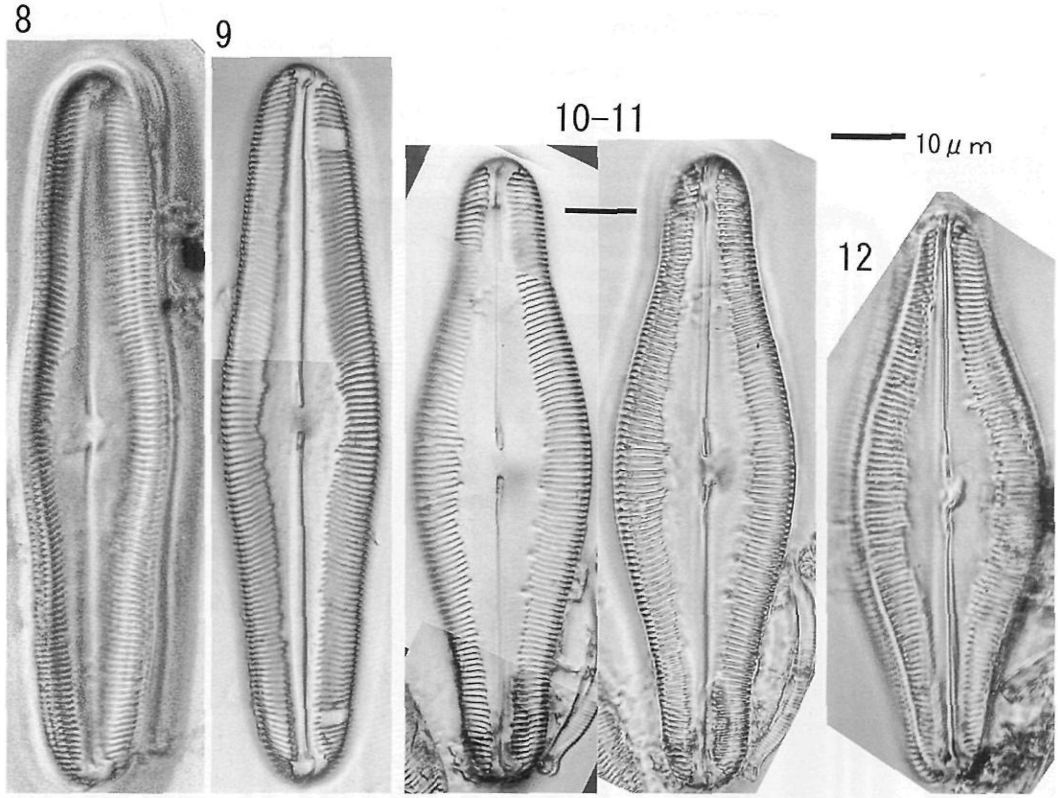
Figs 1-7. *Pinnularia acidobionta* sp. nov. with linear form. Bar = 10 μm. **Fig. 1.** TNS-AL-55123s, DIC (Differential interference contrast image). **Fig. 2.** TNS-AL-55123s, DIC. **Fig. 3.** TNS-AL-55128sa, DIC. **Fig. 4.** TNS-AL-55128sa, DIC. **Fig. 5.** TNS-AL-55127s, BF (Bright-field image). **Fig. 6.** TNS-AL-55054s, DIC. **Fig. 7.** TNS-AL-55128sa, BF.

Holotype: TNS-AL-55128sa in TNS (figs 10, 11).
Type Material: TNS-AL-55128m in TNS.
Type Locality: Lake Usori, Osorezan, Aomori, Japan.

Two types of valve form are found. The linear form (Figs 1-7) is common in Lake Usori and its outflow (River Sho-zu). In contrast, the rhombic-lanceolate form (Figs 8-12) is rare and is observed only in the River Sho-zu (TNS-TW-5015sa) and an enclosed area in Lake Usori (TNS-AL-55128sa). The outlines of both types seem to be very different and could be considered as different taxa. However, the outline is the only difference between the two forms and an intermediate form has also been observed (Figs 7, 8), thus we interpret them as variations of a single taxon.

This taxon is very similar to *P. krasskei* Hust. However, the axial area of this taxon contacts the end of the valve, and differs from *P. krasskei*. The size of the axial area of this taxon is also larger than that of *P. krasskei*. The density of the striae becomes finer toward the ends of the valve in *P. krasskei* but not in this new taxon.

Because, this taxon is common in Lake Usori (pH ranged from 2.0 to 3.7) and River Sho-zu (pH is 2.7) (Table 1), it should be an acidobion-



Figs 8-12. *Pinnularia acidobionta* sp. nov. with rhombic-lanceolate form. Bar = 10 μm. **Fig. 8.** TNS-AL-TW-5015sa, BF. **Fig. 9.** TNS-AL-55128sd, DIC. **Figs 10, 11.** TNS-AL-55128sa (Holotype specimen, **Fig. 10.** DIC, **Fig. 11.** BF). **Fig. 12.** TNS-AL-55053sa, DIC.

tic taxon. This taxon is not observed in Entsu-ji (small river: pH ranged from 1.3 to 2.7) and several ponds at Gokurakuhama (pH ranged from 1.3 to 1.7) and *Pinnularia acidojaponica* M. Idei et H.Kobayasi is dominant in such areas. The chemical differences between both areas, are uncertain. This taxon was observed four times in thirty years (1972, 1974, 2000 and 2003), but probably existed continuously during this period.

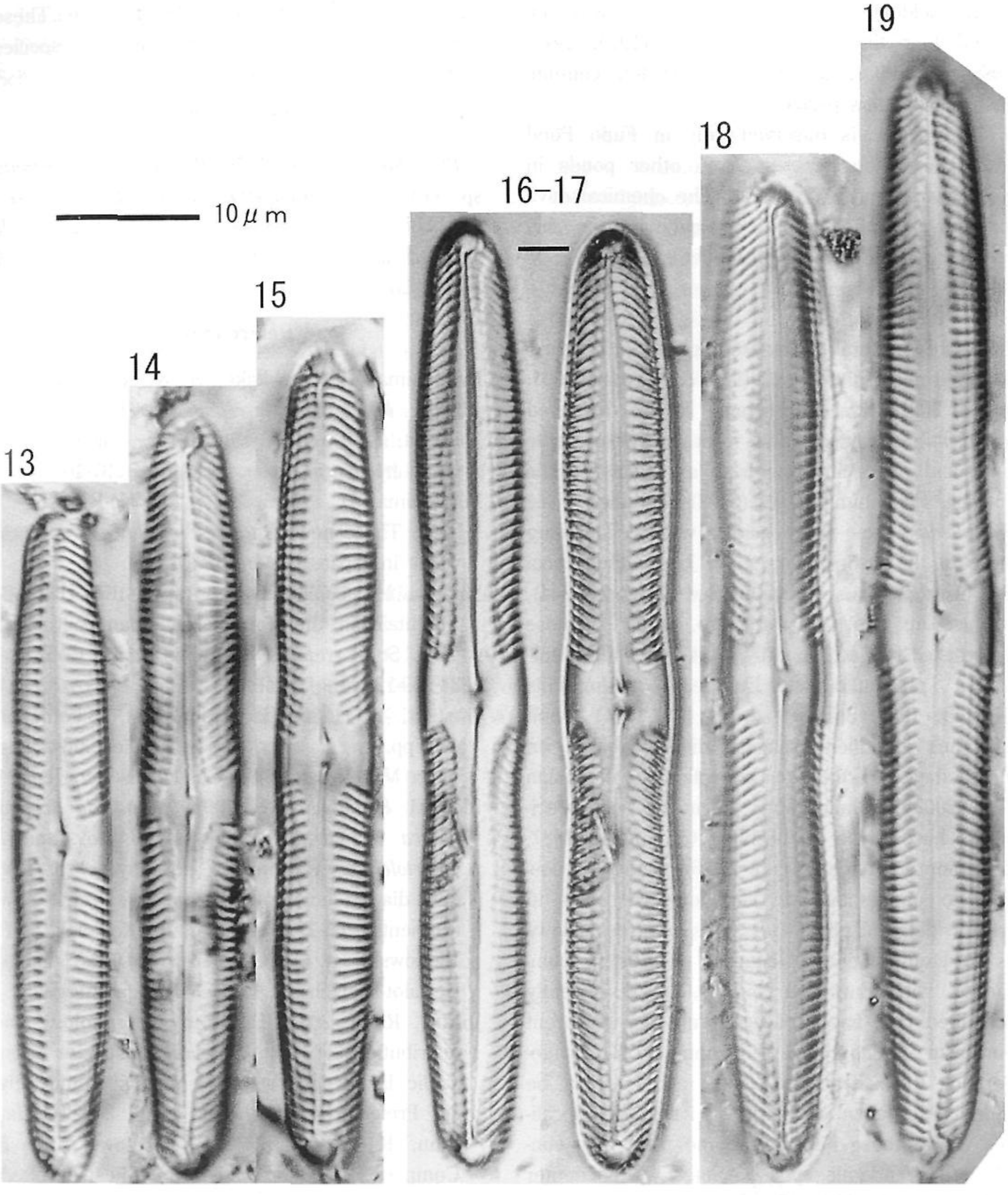
This species has been observed only in the Osorezan area and is suggested to be endemic to the Osorezan area.

Pinnularia kirisimaensis **Tuji & Tosh.Watan., sp. nov.** **Figs 13-19**
Synonym: *Pinnularia* sp. sensu Watanabe & Oyanagi 1978.

Valvae lineares, margine triundulata, apicibus late rotundatis, 50-85 μm longae, 7-9 μm latae. Raphe anguste lateralis, poris centralibus parvis, fissuris terminalibus formatis similibus signo interrogationis. Area axialis angusta, area centralis rhomboidalis, fasciam latam formans ad margines valvae. Striae transapicales radiantes in media parte valvae, convergentes ad apices, 13-15 in 10 μm.

Valves linear, sides triundulate, ends broadly rounded, length 50-85 μm, breadth 7-9 μm. Raphe narrowly lateral, central pores small, drop-shaped, bent laterally, terminal fissures shaped like small question marks. Axial area narrow, central area rhombic, widened into a mostly asymmetric fascia. Striae 13-15/10 μm, radiate in the middle, convergent towards the ends.

Holotype: TNS-AL-55402sa in TNS (figs 16, 17).
Type Material: TNS-AL-55402m in TNS.



Figs 13-19. *Pinnularia kirisimaensis* sp. nov. Bar = 10 μm. **Figs 13-15, 18, 19.** TNS-AL-TW-6881sa. **Figs 16, 17.** TNS-AL-55402sa (Holotype specimen) ; **Figs 13-16, 19.** DIC. **Figs 17, 18.** BF.

Type Locality: Fudo Pond, Kirishima, Kyusyu, Japan.

This taxon was first reported by Watanabe & Oyanagi (1978) as *Pinnularia* sp. from the same locality. This taxon is similar to *Pinnularia laxa* Hust. The axial area of this taxon is narrow, roughly circular, and is very close to the valve end. *Pinnularia laxa* has a larger and more elliptic axial area, and is relatively far from the valve end. The outline of this taxon also differs from *P. laxa*.

Because this taxon is observed in Fudo Pond (pH ranged from 3.8 to 6.5, Table 2), it should

be an acidobiontic taxon. This taxon was observed four times in thirty years (1975, 1977, 1985 and 2003), but probably existed continuously during this period.

This species is observed only in Fudo Pond and has not been observed in other ponds in the Kirishima area (Table 2). The chemical environment of Fudo Pond is unique, and so this species is considered to be endemic.

Discussion

Recently, several *Pinnularia* taxa have been reported from acidic waters (Idei & Mayama 2001, Jordan 2001). Idei & Mayama (2001) described two *Pinnularia* taxa, one from Japanese acidic lakes and rivers and one from a Japanese acidic hot spa. Fukushima *et al*. (2002) described three *Pinnularia* taxa from acidic waters including those of the Osorezan area. In Japan, these taxa had been previously misidentified (Negoro 1944), because up until 20 years ago, many Japanese diatomists had access only to the limited information presented in European monographs (Hustedt 1930, Schmidt *et al*. 1874-1904) , and had thus identified Japanese diatoms based on these data, leading to considerable confusion (Tuji 2003b). Photographs of many type specimens have been published (Simonsen 1987, Krammer & Lange-Bertalot 1986) making it possible to understand the variation of species in greater detail (Tuji 2003a). This progress allows us to study endemic Japanese species in comparison with European species. These recently described taxa have not been reported in recent European monographs (Krammer & Lange-Bertalot 1986, Krammer 2000), and so may be endemic to Japan or East Asia. The type localities where these new taxa come from may contain other endemic species. Since we encounter difficulty in classifying Japanese diatom taxa from acidic waters using these European monographs, we may need to describe more new species from acidic waters.

Acidic waters are isolated pocket waters in Japan, making it difficult for attached diatom species to emigrate to other waters. This geological isolation is very similar to that experienced by the flora of isolated islands. Furthermore, Japanese acidic waters are located close to geological environments such as hot springs, and these areas continue to evolve in geological time. These conditions may produce many Japanese species endemic to acidic waters.

摘　要

Pinnularia の二新分類群, *Pinnularia acidobionta* sp. nov. および *Pinnularia kirisimaensis* sp. nov. を記載した。両分類群は，宇曽利湖（恐山湖，青森県）および不動池（霧島，九州）の固有種と考えられた。

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